ME68B Numerical Methods in Mechanical Systems 2010/2

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1 Motivation

The purpose of this course is to provide an introduction to numerical and mathematical tools to solve differential equations that govern a wide range of mechanical systems. Examples of models from heat transfer, fluid mechanics and dynamical systems will be studied.

2 Topics

- **Interpolation and numerical integration**: Taylor series expansion. Polynomial interpolation. Interpolatory quadratures.
- **Numerical solution of ordinary differential equations**: Stability concepts. Finite difference schemes. One-step numerical methods. Stability and convergence analysis. Euler method. Multi-step methods. Adams methods. Runge Kutta method.
- **Numerical solution of partial differential equations**: Finite difference approximation. Convection-diffusion problems. Parabolic and hyperbolic initial boundary problems. One-dimensional heat conduction equation. Implicit and explicit schemes. Poisson's equation. Jacobi, Gauss-Seidel and relaxation methods. Introduction to spectral methods.
- **Nonlinear equations**: Root finding methods for nonlinear equations. Secant and Newton's method. One-dimensional maps. Fixed points and logistic maps. Introduction to Lorentz Equations.
- **Dynamical systems**: Introduction to bifurcations. Introduction to perturbation methods. Duffing's equations. Van der Pol oscillator.

3 Prerequisites

Heat Transfer or Transport Phenomena.

4 Coursework

The coursework will include individual computational/analytical homeworks and a final project.